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RESTORING
MOUNTAIN ECOSYSTEMS

Challenges, case studies and recommendations for implementing the UN Decade Principles for Mountain Ecosystem Restoration

Mountain Partnership

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MOUNTAIN ECOSYSTEMS

Challenges, case studies and recommendations for implementing the UN Decade Principles for Mountain Ecosystem Restoration

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Abbreviations

asl	above sea level
CAMP Alatoo	Central Asian Mountain Partnership Alatoo
DECOIN	Defensa y Conservación Ecológica de Intag
ECOAN	Asociación Ecosistemas Andinos
FAO	Food and Agriculture Organization of the United Nations
GBF	Global Biodiversity Framework
GRID-Arendal	United Nations Environment Programme-Global Resource Information Database - Arendal
GVTC	Greater Virunga Transboundary Collaboration
ha	hectare
ICIMOD	International Centre for Integrated Mountain Development
IGCP	International Gorilla Conservation Programme
IMD	International Mountain Day
IUCN	International Union for Conservation of Nature
IUCN CEM	International Union for Conservation of Nature's Commission Ecosystem Management
MGNP	Mgahinga Gorilla National Park
MPS	Mountain Partnership Secretariat
NGO	non-governmental organization
SDG	Sustainable Development Goal
SER	Society for Ecological Restoration
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural
UNGA	United Nations General Assembly
USA	United States of America
VNP	Volcanoes National Park
WWF	World Wide Fund for Nature

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Foreword

Mountains are home to a variety of ecosystems that provide vital services directly to 1.1 billion people and billions of others living in connected lowland areas. Half of humanity depends on mountains for the provision of freshwater alone. Mountain ecosystems cool local temperatures, increase water retention, provide carbon storage, and reduce the risk of erosion and landslides. Mountain forests, wetlands and grasslands also host and support half the world's biodiversity hotspots – areas characterized by high levels of species richness that are threatened with destruction.

But the world's mountain ecosystems are under attack due to their particular sensitivity to the planetary crises of climate change, biodiversity loss, food insecurity and pollution and waste. Evidence shows that mountain ecosystems are affected at a faster rate than many other terrestrial habitats. Mountain glaciers and snow cover are shrinking and retreating at unprecedented rates, impacting the quality and quantity of freshwater available. Increasing temperatures are driving many species uphill and often towards extinction. Microplastics have been found in the most remote mountain sites, including at Mount Everest. Natural disasters and shocks, including flash floods, landslides, and wildfires, are growing in frequency, impacting the livelihoods of mountain communities.

Women, youth and Indigenous Peoples who are the most reliant on mountain ecosystems and their goods and services are particularly vulnerable. The Food and Agriculture Organization of the United Nations (FAO) and the United Nations Environment Programme (UNEP) have joined forces to drive investment in inclusive and gender-responsive approaches that safeguard and conserve nature and biodiversity while also increasing climate-adapted resilience for the world's mountain regions.

To halt, prevent and reverse the degradation of ecosystems and to achieve the United Nations 2030 Agenda for Sustainable Development, the United Nations General Assembly (UNGA) declared 2021–2030 the United Nations Decade on Ecosystem Restoration (UN Decade). Co-led by FAO and UNEP, it is building a strong, broad-based global movement to ramp up restoration and conservation and put the world on track for a sustainable future.

This publication, jointly developed by the Mountain Partnership Secretariat at FAO and UNEP, analyses several mountain ecosystem restoration projects and recommends how the UN Decade's Ten Principles for Ecosystem Restoration can be applied to mountain ecosystems. Mountain restoration success stories from initiatives that have been selected or shortlisted as the UN Decade's World Restoration Flagships are also highlighted. As the theme of this year's International Mountain Day 2023 is "Restoring Mountain Ecosystems", this publication provides an important contribution, in addition to celebrating the Five Years of Action for the Development of Mountain Regions 2023–2027.

The world depends on healthy and functioning mountain ecosystems. Greater efforts are needed to safeguard and revitalize these vital ecosystems, for climate, biodiversity, livelihoods and many other sustainable development benefits. It is our hope that the mountain-specific approaches to ecosystem restoration that are presented here will be of value for application in locally appropriate contexts by practitioners in mountain landscapes around the world.

Zhimin Wu, Director
of Forestry Division, FAO

Susan Gardner, Director
of Ecosystems Division, UNEP

Farming village in the Ethiopian highlands, Simien Mountains

©UNEP

Glacier-covered mountains in Kyrgyzstan
©Aidana Abakova

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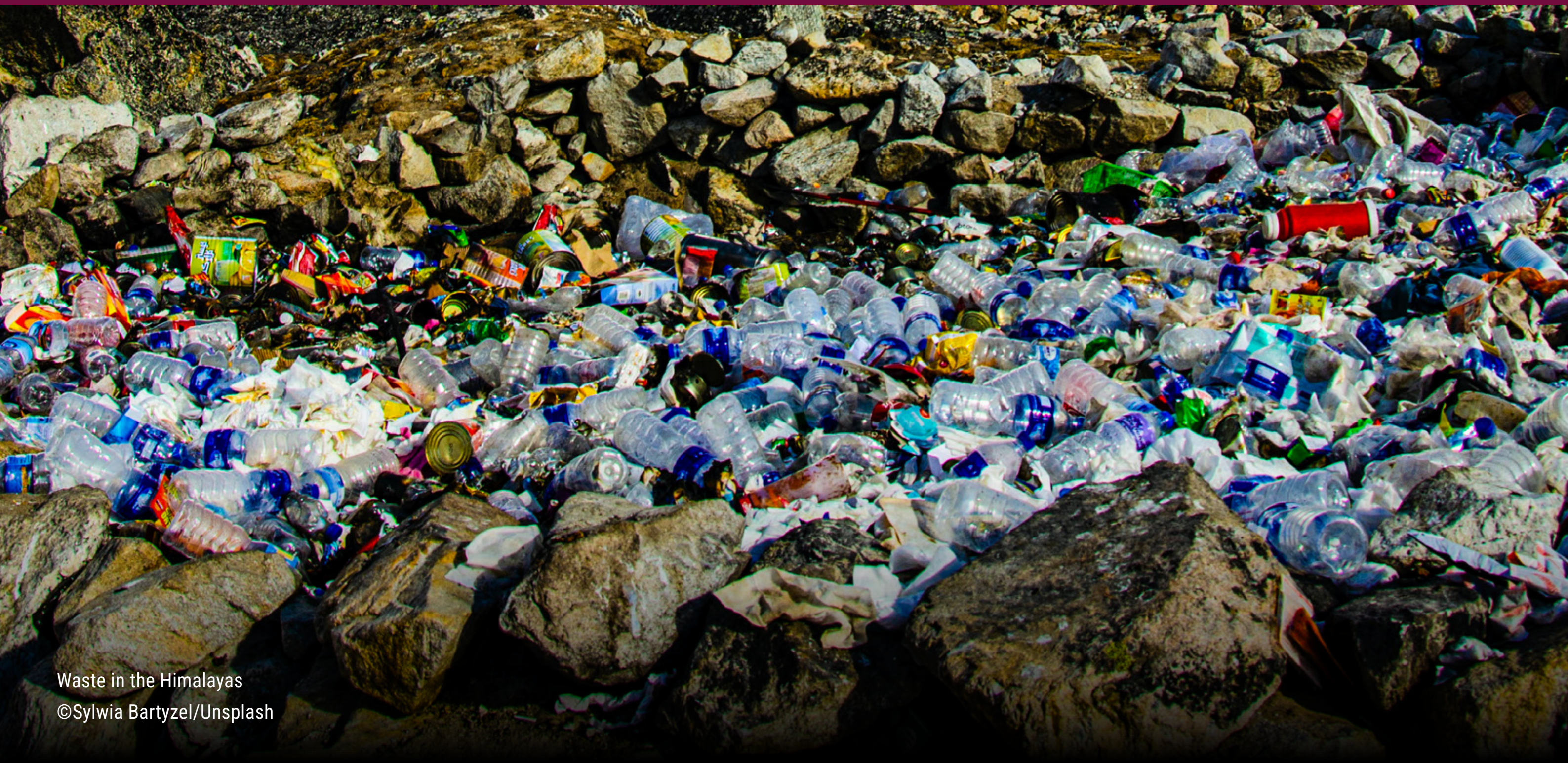
Introduction



Waste in the Himalayas
©Sylwia Bartyzel/Unsplash

Why mountains matter and the mountain agenda

Mountains cover about one-quarter of the Earth's land area and are home to 1.1 billion people – 15 percent of the world's population (Romeo *et al.* 2020). They host 25 of the world's 34 biodiversity hotspots (United Nations Environment Programme [UNEP] *et al.* 2020), as well as rare plants and animals such as snow leopards and mountain gorillas. Mountains are home to a variety of ecosystems, with forests covering approximately 40 percent of the global mountain area.

Healthy and conserved mountain ecosystems are of paramount importance to people living in the mountains and to billions of people living in connected lowland areas. Two-thirds of irrigated agriculture globally depends on runoff contributions from mountains (Adler *et al.* 2022). Other key ecological services supplied by healthy mountain ecosystems include reducing the risk of erosion and landslides, cooling local temperatures, and maintaining pools of genetic resources for locally adapted crops and livestock (Egan and Price 2017).

Mountains are not spared from the triple planetary crises of climate change, biodiversity loss, and pollution. Mountain ecosystems are very vulnerable, especially to the increasingly adverse impacts of climate change, resulting in the retreat of mountain glaciers, permafrost thaw, mass loss of ice sheets and a decline in the depth, extent and duration of snow cover. Deforestation, forest fires and forest degradation, land degradation and exposure to risk of disasters are common in many mountain areas, all negatively affecting sustainable livelihoods and human well-being, especially in developing countries (Adler *et al.* 2022). One in two rural mountain people living in developing countries is vulnerable to food insecurity (Romeo *et al.* 2020). Uncontrolled dumping and open burning of waste, including plastic waste, pose ecological and health risks in mountains. Microplastics have even been found just below the summit of Mount Everest.[1]

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[1] Mount Everest is also known as *Chomolungma*, 'Goddess, Mother of the World', in Tibetan, and Sagarmatha, 'Head above the Clouds' in Nepali.

Indigenous Peoples in mountains have unique and valuable local knowledge, traditions and cultural practices that contribute to the conservation of biodiversity, effective land management strategies and sustainable food systems. Nature-based solutions and ecosystem-based adaptation to restore ecosystems should build on such knowledge, support and empower Indigenous Peoples to build resilience, as well as to reduce dependencies on unsustainable practices. Resources such as the Adaptation at Altitude Solutions Portal, as well as the United Nations Environment Programme Mountains ADAPT Solutions booklets provide several tested mountain-specific adaptation solutions, many of which include strong restoration and ecosystem-based adaptation elements (United Nations Environment Programme [UNEP] and GRID-Arendal 2022). For example, in the Caucasus Mountains, in the Tusheti region of Georgia, rotational grazing and natural barriers are being used to reduce erosion of slopes, a prime example of local ecosystem restoration as an adaptation solution.

The importance of mountains for life and the challenges that ecosystems and people in mountain areas face have gained growing international recognition and attention. Notably, **UNGA Resolution 76/129** declared 2022 as the International Year of Sustainable Mountain Development, at the proposal of the Government of Kyrgyzstan. This was the beginning of a landmark process to recognize the need to conserve and restore mountains as a life support system and provided a sound basis for further collaborative and substantive work toward sustainable mountain development.

The Resolution invited the **Mountain Partnership** – the United Nations alliance dedicated to mountain ecosystems and environments – to facilitate observance of the International Year in collaboration with all relevant organizations, including strong support from UNEP. During the International Year, the Mountain Partnership supported the organization of more than 60 events, developed a global communication campaign and logo, and established and coordinated an Open-ended Scientific Committee that produced several policy briefs to support policy-science dialogue for sustainable mountain development.

The main outcome of the International Year of Sustainable Mountain Development was the proclamation of the period 2023–2027 as **Five Years of Action for the Development of Mountain Regions** by UNGA Resolution 77/172. The Five Years of Action aim to enhance the international community's awareness of the problems faced by mountainous countries and give new impetus to efforts made to address these challenges.

One other key political outcome of 2022 – although not directly related to mountains – is the Kunming-Montreal Global Biodiversity Framework (GBF), which has 23 action-orientated global targets for urgent action, including one related to the restoration of terrestrial ecosystems. Although the GBF does not have any ecosystem-specific goals and targets, strong emphasis is expected to be placed on approaches that identify scientific and technical opportunities for supporting implementation of the Framework, including its implications for the programmes of work of the Convention on Biological Diversity, such as the **one related to mountain biodiversity**.

A **global framework for action** has been developed to observe and support the Five Years of Action for the Development of Mountain Regions. It reflects the collective efforts of the multistakeholder global movement in support of sustainable mountain development, particularly represented by members of the Mountain Partnership.

The framework aims to contribute to three interconnected, long-term impacts:

- Mountain ecosystems are conserved and restored for production and protection purposes, and biodiversity is sustainably protected and used for the continued provision of global ecosystem services.
- People living in mountains have increased resilience to climate change and disasters.
- Quality of life in mountain areas is improved.

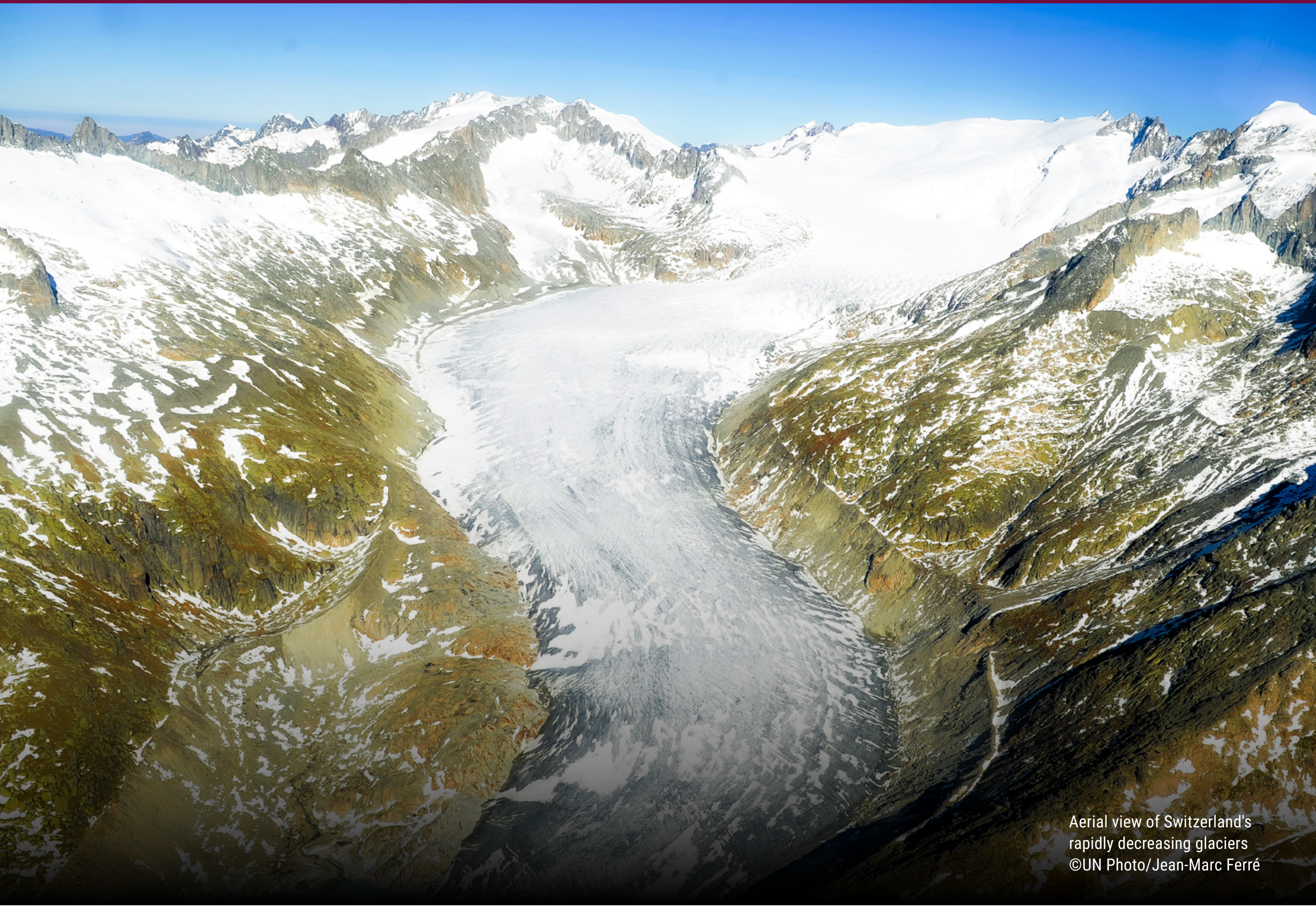
To draw further attention to the global value that healthy and well-functioning mountain ecosystems have for people and the planet, “Restoring Mountain Ecosystems” was selected as the theme of International Mountain Day (IMD) 2023. International Mountain Day was first proclaimed by the UNGA in 2003. The annual event offers a chance to increase awareness about the relevance of mountain ecosystems and to call for nature-based solutions, best practices and investments that will help to build resilience, reduce vulnerability and increase the ability of mountain communities to adapt to threats and extreme climatic events. FAO is the lead United Nations agency responsible for coordinating IMD (see Box). With its mountain ecosystem restoration theme, IMD 2023 aims to promote the restoration of mountain ecosystems as often neglected ecosystems within the context of the **United Nations Decade on Ecosystem Restoration 2021–2030**, co-led by FAO and UNEP.

This publication is aimed at the international mountain community and at restoration practitioners and technicians. It highlights how the UN Decade on **Ecosystem Restoration’s Principles** developed by UN Decade partners to create a shared vision of ecosystem restoration can be applicable to mountain ecosystems. It presents a number of best practices and success stories from various mountain regions around the world that have been recently profiled through the launch of the first **restoration flagship initiatives under the UN Decade**. It aims to emphasize mountain ecosystems and their need for restoration, as these continue to be neglected at global policy level. This is part of a wider contribution to the efforts of the UN Decade and its partners.

INTERNATIONAL MOUNTAIN DAY

11 December
International
MOUNTAIN DAY
2023

International Mountain Day has its roots in 1992, when the adoption of Chapter 13 of Agenda 21 “Managing Fragile Ecosystems: Sustainable Mountain Development” at the United Nations Conference on Environment and Development set a milestone in the history of mountain development. The increasing attention paid to the importance of mountains led the United Nations General Assembly to declare 2002 as the UN International Year of Mountains. On this occasion, the United Nations General Assembly designated 11 December, from 2003 onwards, as International Mountain Day. FAO is the coordinating agency for the preparation of this annual celebration and is mandated to lead its observance at global level. The Mountain Partnership Secretariat in the FAO Forestry Division is responsible for coordinating this international process.



Aerial view of Switzerland's rapidly decreasing glaciers ©UN Photo/Jean-Marc Ferré

Global degradation drivers impacting mountain ecosystems

Climate change and land-use changes are the main global drivers negatively affecting mountain regions worldwide. Both degrade the ecological structure, functioning and important ecosystem services required to maintain the livelihoods of people living in mountain areas, such as water provision for agriculture and livestock production, reducing damage from natural disasters, and erosion protection, as well as culture and recreation (Palomo 2017; Food and Agriculture Organization [FAO] 2019; Hock *et al.* 2019; Adler *et al.* 2022). It is predicted that by 2050 some 1.5 billion people (24 percent of the global lowland population) will depend on freshwater runoff from mountains, which is significantly higher than the 0.2 billion (7 percent) in the 1960s (Viviroli *et al.* 2020). In addition to the billions of affected people in mountain regions worldwide, the degradation drivers also have extreme negative effects on the livelihoods of vulnerable people who lack the capacity and resources to deal with their effects. For instance, about 346 million rural mountain people in developing countries were vulnerable to food insecurity in 2017. Of these, 178 million lived in mountain areas exposed to progressive land degradation (46 million of whom lived in croplands, further exacerbating their already existing vulnerability to food insecurity), which negatively impacts the productivity of the land and further exacerbates existing vulnerabilities (Food and Agriculture Organization of the United Nations [FAO] and United Nations Convention to Combat Desertification [UNCCD] 2019; Romeo *et al.* 2020).

Global drivers negatively impact a variety of mountain ecosystems that include the cryosphere, grasslands, forests, wetlands including peatlands, rivers and lakes. Climate change has impacted mountain ecosystems through the increase of air temperature, changes in precipitation patterns and in frequency and intensity of extreme weather events, which have consequently produced droughts, soil erosion, desertification, changes in vegetation cover, glacier melt, water scarcity, and favourable conditions for wildfire events (Hock *et al.* 2019; Jin *et al.* 2021; Adler *et al.* 2022). For instance, wildfires have advanced upslope about 252 m in 34 years in the western part of the United States of America (USA), reaching high-elevation sites at unprecedented rates. A case in point is the Sierra Nevada, where the burning rate above 3 000 m was 433 hectares (ha)/year between 1984 and 2000 and increased to 4 130 ha/year between 2001 and 2017. Such advances are consistent with the observed warming in the region (Alizadeh *et al.* 2021). In some mountain regions, fires play important roles in the forest ecology (for example, minimizing the spread of pest insects), but extreme wildfires and wildfires in ecosystems that are not naturally fire-prone cause negative impacts on both ecosystems and society (Gutierrez *et al.* 2021).

Upslope advances of non-native species are also becoming more common in mountain ecosystems, causing the suppression of native species and impacting the provision of ecosystem services (Dainese *et al.* 2017). For instance, non-native fungus (*Cronartium ribicola*) and pine beetle outbreaks (*Dendroctonus ponderosae Hopkins*) are reducing Whitebark Pine (*Pinus albicaulis Engelm*) forests in the Rocky Mountains of the USA (Hansen *et al.* 2016). Similarly, the introduced plant (*Rumex alpinus*), imported from the European Alps to the Giant Mountains has suppressed native vegetation important for livestock production (Bucharova and Krahulec 2020). In the mountains of South Africa, invasive pines have reduced water availability for ecosystems and therefore also for society (Fill *et al.* 2017).

Forest fire in Portland, United States of America
©Karsten Winegeart/Unsplash

Landslides are among the deadliest hazards affecting people living in mountain regions (Froude and Petley 2018) and are degrading mountain ecosystems due to the removal of upland surface layers. As of 2017, an estimated 516 million people living in rural areas (about 80 percent of the total rural population in rural mountain areas in developing countries) lived in areas affected by past natural hazards (Romeo *et al.* 2020)[2]. Landslides occur in mountains as a result of several factors, some of which are unstable slopes of a certain steepness, seasonal glacier melt and heavy precipitation events, as well as erosion processes. It has been predicted that the number of people and the volume of infrastructure at risk of landslides will increase in mountain regions, where the frequency and intensity of precipitation are projected to rise (Haque *et al.* 2019; Adler *et al.* 2022). Landslides not only impact society, but also increase the susceptibility of habitat and biodiversity loss. About 25.8 percent of the global mountainous areas are considered highly vulnerable to landslide risks and biodiversity loss (Li, Jenkins and Xu 2022).

Stripping bark from invasive species in Uganda
©Joseph Arinaitwe/Uganda Wildlife Authority (UWA)

Human activities have degraded mountain regions worldwide through deforestation, intensive agriculture, pollution and the construction of infrastructure. Deforestation impacts mountain ecosystems, causing loss of forest coverage and biodiversity (Bohara *et al.* 2019; Christmann and Menor 2021; He *et al.* 2023). Reforestation and afforestation have been found to control soil erosion that originates from intensive agricultural activities (Li *et al.* 2020). However, unsustainable practices of afforestation, planting trees where they did not grow in the past and using non-native species that typically absorb large amounts of water, can also have a negative impact on water supplies as a result (Tian *et al.* 2016; Xiao, Xiao and Sun 2020). In the mountain region of Chongqing and the Yunnan-Guizhou Plateau, southwest China, the uptake of water by afforestation was estimated to have reached up to 40.42 billion m^3 between 1980 and 2015, equivalent to 10.69 percent of the annual water supply of the region in that period, resulting in water shortage events (Xiao, Xiao and Sun 2020). Although changes in land use including afforestation and reforestation had small inhibitory effects on water yield in some lowland sites in Northeast China, they also had large positive impacts on stopping soil erosion (Xiao, Xiao and Sun 2020; Yin, Zhang and Zhang 2022; Wang *et al.* 2022).

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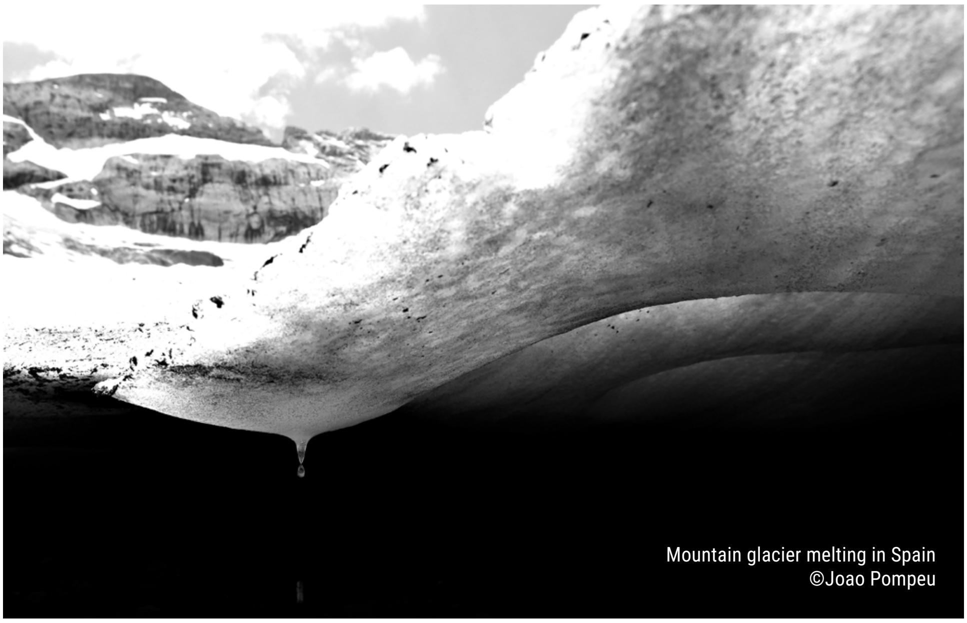
[2] The data sets used identify the following as natural hazard events: cyclones, drought, earthquakes, floods and landslides.

The main agricultural impacts on mountain ecosystems are related to land pressure from unsustainable livestock production and intensive agriculture. For instance, overgrazing has degraded *Polylepis* forests and caused extreme soil erosion (gully erosion) in the Andean mountains of Argentina (Barri *et al.* 2021). Furthermore, overgrazing and water deviation have degraded high-elevation peatlands in the tropical Andes, resulting in loss of water, carbon and vegetation and in extreme soil erosion (Planas-Clarke *et al.* 2020; Suarez *et al.* 2022; United Nations Environment Programme [UNEP] 2022a). Similar pressures, in addition to overuse of fertilizers, have been reported for grasslands in the White Carpathian Mountains in Czechia, and forests in the Dieng Mountains in Indonesia (Marliana and Rühe 2014; Albert *et al.* 2021). Hydrological changes due to shifts in climate may exacerbate the impacts caused by intensive livestock production in high-elevation peatlands in the Andes, causing increased greenhouse gas emissions, and further exacerbating their declining carbon storage capacity (Planas-Clarke *et al.* 2020).

The construction of infrastructure has also contributed to the degradation of mountain ecosystems. Water infrastructure, dams and river channelization result in riverbank erosion and sediment liberation, which impact water quality and the ecology of water resources (Cavaillé *et al.* 2018; Mikuś *et al.* 2021). Additionally, mining activities and increased urbanization, which involve developing land for roads and other infrastructure, have degraded mountain ecosystems (Jiang *et al.* 2021). For instance, the construction of roads and mining activities has degraded grasslands, shrubs and soils in the mountains of Brazil (Le Stradic, Buisson and Fernandes 2014; Gomes *et al.* 2018). For the installation of skiing facilities, extensive removal of vegetation and soil is required, impacting native vegetation and the physico-chemical and structural properties of soils. Following the installation of ski infrastructure, native plants often fail to grow due to the damaged soil conditions or suppression by non-native plants that grow better in the new environment (Pintaldi *et al.* 2017), resulting in the loss of plant diversity and homogenization of the landscape.

Women in a nursery for reforestation of Buddleja trees, Bolivia (Plurinational State of)
©FAO/Roberto Faidutti



Mountain glacier melting in Spain
©Joao Pompeu

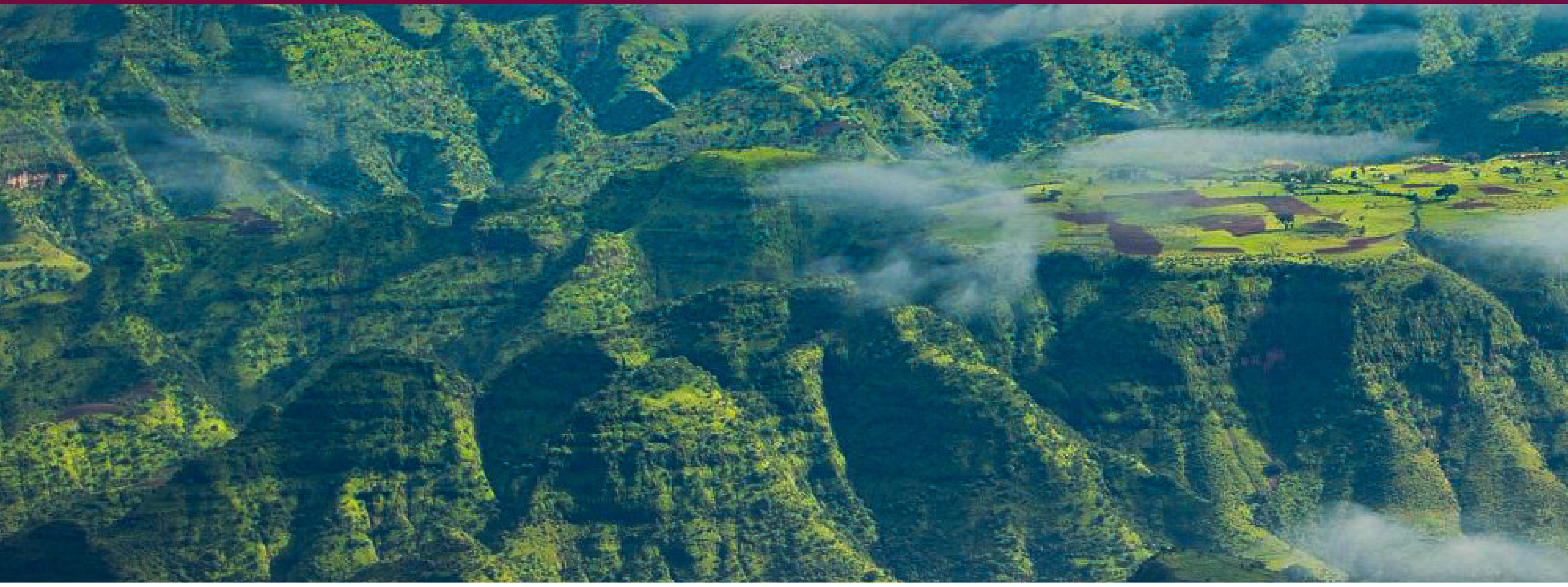
As of 2020, 57 percent of the global mountainous area was under intense human pressure, mainly at low elevations and mountain bases (Elsen, Monahan and Merenlender 2020), resulting in mountain ecosystems being more intensely degraded at lower elevations due to the pollutants emitted by agricultural, urban, mining and industrial activities (Elsen Monahan and Merenlender 2020; Machate *et al*. 2023). However, atmospheric deposition of pollutants has been observed to negatively impact mountain ecosystems at high altitudes as well, such as forests, aquatic ecosystems and glaciers (Kim *et al*. 2015; Fakhraei *et al*. 2016; Machate *et al*. 2023). For instance, black carbon particles, emitted into the atmosphere from the incomplete combustion of fossil fuels and biomass, darken snow and ice surfaces on mountains, making them less reflective and more light absorbent, resulting in further increases of glacier retreat (International Centre for Integrated Mountain Development [ICIMOD] 2015). In the United States of America, atmospheric deposition has impacted water quality, fish populations and food webs of freshwater ecosystems in mountains. Water quality and ecology that have been affected by elevated atmospheric deposition can take a long time to recover, even after legal regulations on atmospheric pollution have been put in place (Sutherland *et al*. 2015; Fakhraei *et al*. 2016).

In conclusion, mountain regions worldwide are facing profound impacts from climate change and uncontrolled human activities, which, in some cases, cause irreversible losses of biodiversity and ecosystems and their functions. Peatland degradation, deforestation, unsustainable afforestation, invasive species proliferation, uncontrolled urbanization resulting in infrastructure expansion, unsustainable agriculture, landslides and other natural hazards, as well as water and air pollution are among the main drivers of degradation impacting mountain ecosystems and people living in and around mountains. Climate change, rising air temperatures, shifting precipitation patterns, extreme weather events, coupled with human activities, also have synergistic effects on mountain ecosystems, causing the degradation of land, such as extreme eroded soil, which affects the livelihoods of people living in and around mountains as a result. Such drivers of degradation will have particularly profound effects on vulnerable people in developing countries. For this reason, immediate actions that include restoration, conservation and sustainable management measures are urgently needed to support climate change adaptation and halt ecosystem degradation, pollution and biodiversity loss in mountain regions.

Gelada Ethiopian highlands
©Duncan Moore

2

The United Nations Decade on Ecosystem Restoration and opportunities for mountains as neglected ecosystems



The United Nations General Assembly declared the period from 2021 to 2030 as the United Nations Decade on Ecosystem Restoration, with the goal of "preventing, halting and reversing the degradation of ecosystems worldwide". To build a common vision on ecosystem restoration, ten restoration principles serving as best practice were adopted to underpin all restorative activities that are part of the continuum of ecosystem restoration, under the UN Decade, and which are applicable across all sectors, biomes and regions (Food and Agriculture Organization [FAO], International Union for Conservation of Nature's Commission on Ecosystem Management [IUCN CEM] and Society for Ecological Restoration [SER] 2021).

To highlight how the UN Decade restoration principles can be specifically applied to mountain ecosystems, UNEP commissioned a review of ten case studies on mountain restoration projects (United Nations Environment Programme [UNEP] 2022b). The following section is derived from this unpublished study. The review was closely coordinated with scientific networks, such as the Global Mountain Biodiversity Assessment and the Mountain Research Initiative. Each selected case study was evaluated against the ten restoration principles, to determine to what extent each principle was addressed in the restoration project. The review was also used to help identify good practices that can be replicated elsewhere. From this process, a set of recommendations was drawn up on how the ten restoration principles can be integrated into mountain ecosystem restoration efforts to strengthen their outcomes.

The ten case studies cover a variety of ecosystems found in mountain regions: forests, grasslands, rivers, bogs and fens, and are located across the following mountain regions: Central Himalaya, European Alps, Carpathians, Rocky Mountains, Andes, Australian Alps, Qinling, Khingan, Min, Changbai, Sanjiang, Yunnan–Guizhou Plateau, Qilian, Tibet plateau, Loess Plateau, Dahei, Altai, Qinghai-Tibet Plateau, Taihang and Mufu, Daba.[3] The case studies also cover different climate zones: tropical, subtropical and temperate; and include elevation gradients that are both above and below the treeline.[4]

The analysed restoration projects arose from a variety of organizations, such as non-governmental organizations (NGOs), governments, research institutions, local communities and individuals. Some initiatives were launched more than 20 years ago, based on relatively limited experience of ecological restoration, but have improved over time, featuring in scientific publications, gaining support and leading to large-scale implementation.

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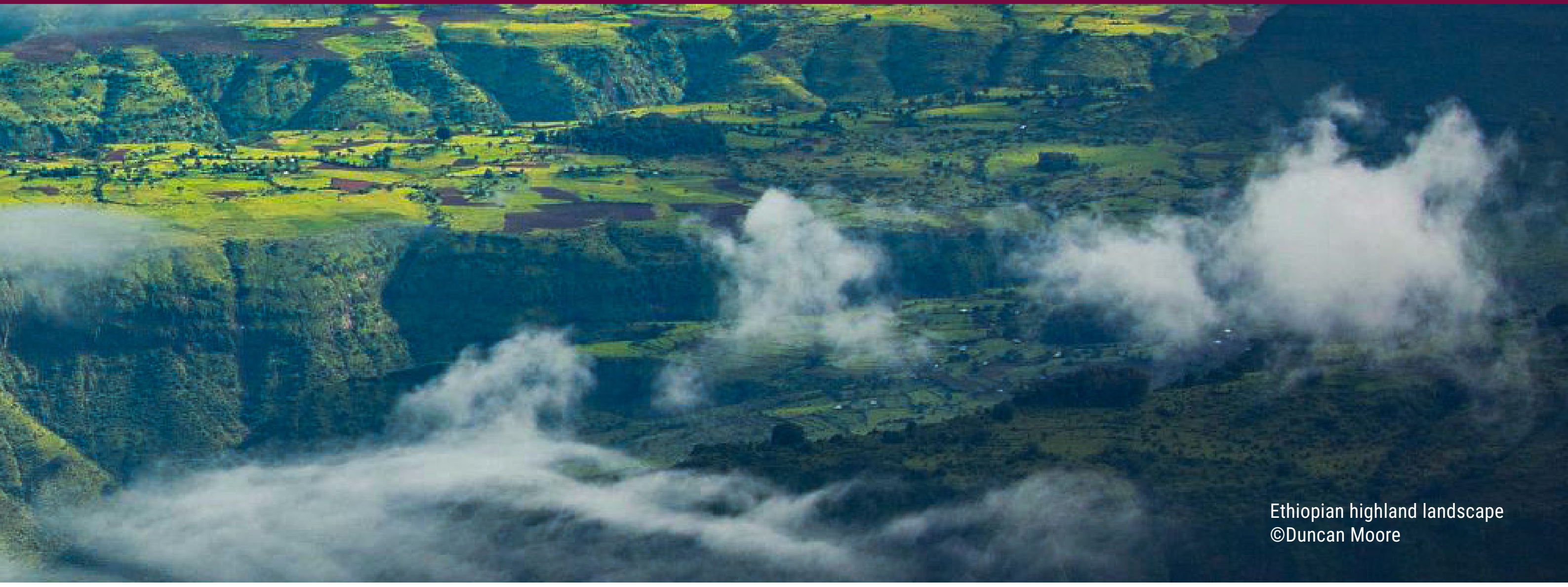
[3] The case studies were selected from a systematic review of scientific literature, and information from NGOs and expert databases such as that of the Society for Ecological Restoration. Case studies were also selected based on a method consisting of various criteria that a restoration project should have.

[4] For this report, the limits of treelines are 2 000 m above sea level (asl) for the temperate and subtropical zones and 4 000 m asl for the tropical zone.



Ethiopian highland landscape
©Duncan Moore

Applying the Ten Principles for Ecosystem Restoration to assess projects in mountains

Principle One. Global contribution: ecosystem restoration contributes to the UN Sustainable Development Goals and the goals of the UN Rio Conventions

All the mountain restoration projects reviewed were found to include objectives related to the achievement of the Sustainable Development Goals (SDGs) and their related targets. In particular, most projects included objectives related to SDG 13 on Climate action[5] and SGD 15 on Life on land.[6] Some of the analysed projects were related to more than three SDGs, such as the restoration of high-elevation grasslands in the Himalayas, India, which responded to the objectives of nine SDGs (Kuniyal *et al.* 2021).

Results of this analysis reveal that the overall goals and objectives of the projects (i.e. ecological, cultural, social, economic, political, etc.) determine the contribution of the restoration initiative to each SDG. They also highlight opportunities for including the SDGs in mountain restoration projects during the planning phase and show that mountain restoration projects can support the achievement of two or more SDGs. For instance, SDG 6 on Clean water and sanitation and SDG 15 on Life on land have specific targets related to the protection and restoration of mountain ecosystems.

Principle Two. Broad engagement: ecosystem restoration promotes inclusive and participatory governance, social fairness and equity from the start and throughout the process and outcomes

Overall, the ten mountain restoration projects engaged a variety of stakeholders, such as governmental institutions, NGOs, research institutions, Indigenous Peoples, local authorities and administrators. Some restoration projects involved multiple types of stakeholders, while others started with a reduced group of individuals and engaged more partners over time. Some participatory activities led to the empowerment of local communities through education, the creation of a School of Ecological Restoration within the local university, and the generation of job opportunities during the restoration process. These are examples of replicable good practices.

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[5] SDG 13: Take urgent action to combat climate change and its impacts.

[6] SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

One initiative that had a positive impact on the livelihoods of local communities was the purchase by NGOs and local communities of lands that were for sale to promote co-management, convert these lands to nature reserves and implement sustainable activities. In the case of community-based reserves in Intag in the Ecuadorian mountains, the NGO DECOIN gave the purchased lands to local communities and parish governments, providing them with land titles and allowing them to benefit from ecosystem services in exchange for protecting the forests and promoting sustainable activities. The community-based reserves in Ecuador generated positive outcomes, including a decrease in outmigration and the empowerment of local communities over their territories (United Nations Development Programme [UNDP] 2019). In Intag, Ecuador, local communities participated in the coordination of reforestation and at the same time acquired stewardship and ownership of their forests, as well as a sense of pride in them.

Principle Three. Many types of activities: ecosystem restoration includes a continuum of restorative activities

Projects included a variety of restorative activities, such as better soil management practices, the extraction of non-native invasive species, avoiding overgrazing, sustainable management of tourism flows and water pollution, the recovery of soil using biodegradable materials, reforestation, planting native species, lowering dams to improve fish migration, and gully restoration. These methods are part of a continuum of restorative activities that improve ecosystem management, restore biodiversity and ecosystem services, prevent degradation and promote natural ecosystem regeneration.

Overall, restoration methods used in the projects aimed to recover biodiversity and ecosystem functions, and to improve the livelihoods of local communities. Recovering biodiversity and ecosystem functions are key to achieving ecosystem health, integrity and human well-being.

Principle Four. Benefits to nature and people: ecosystem restoration aims to achieve the highest level of recovery for biodiversity, ecosystem health and integrity, and human well-being

Good examples of benefits to nature were found in projects assessed: in the restoration of a 25 year-old *Polylepis* forest of 22 ha in the Argentinean Andes, which subsequently led to recovering the diversity of other living organisms; in the reforestation of 200 000 ha along mountain streams of the Carpathian Mountains in Romania; and in the control of large amounts of soil erosion in the Indian Himalayas.Based on the projects assessed, benefits to people included the generation of jobs during the restoration, the empowerment of people through education and awareness-raising, and the recovery of ecosystem services, such as recreational values for ecotourism.

A key part of Principle Four is the promotion of natural recovery. In this context, most of the restoration projects assisted the natural recovery of ecosystems using native species and intended to be restorative and not cause further degradation. However, some restoration initiatives that applied massive afforestation negatively affecting water resources in some lowland

Carpathian Mountains
©David Iordan/Unsplash

sites (Xiao, Xiao and Sun, 2020; Yin, Zhang and Zhang, 2022). Moreover, none of the restoration projects analysed directly assessed net gain for biodiversity, ecosystem health and integrity, and human well-being, through the restoration activities.[7]

Principle Five. Addresses causes of degradation: ecosystem restoration tackles the direct and indirect causes of ecosystem degradation

All the projects analysed implemented restoration activities to address the direct causes of ecosystem degradation. Good examples include the exclusion of grazing and strict controls on tourism activities to restore grasslands and soil in the Himalayas, India (Kuniyal *et al.* 2021); overgrazing control to restore *Polylepis* forests in the Andes, Argentina (Society for Ecological Restoration [SER] 2023); and the control of pollutants discharged into the river basin during improvement of river connectivity in the Carpathian Mountains, Poland (Mikuś *et al.* 2021).

Examples of how to manage land use sustainably include initiatives related to the purchase of land when available for sale by NGOs, local communities and private organizations with the aim of restoring and protecting forests, as in the case of Foundation Conservation Carpathia in the Southern Carpathians (Făgăraș Mountains) and Defensa y Conservación Ecológica de Intag (DECOIN) in the Andes, Ecuador. These initiatives have promoted co-management with local communities, thereby guaranteeing the long-term restoration and conservation of the ecosystems (Wilson, Coomes and Dallaire 2019; Hartup, Ockendon and Pettorelli 2022). These initiatives also highlight the importance of actions taken by NGOs to launch restoration activities in areas where other economic interests have predominated.

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[7] Net gain is defined as a positive improvement from restoration's contributions to biodiversity, ecosystem integrity and human well-being, using the degraded state as a baseline, and measured at appropriate temporal and spatial scales. Measurement of net gain should include intended as well as unintended consequences of restoration activities, within and outside the restoration site. Because net gain by definition is measured against the degraded baseline, it only applies to ecosystems that have been degraded (i.e. it is not appropriate to measure net gain of non-degraded ecosystems).

Principle Six. Knowledge integration: ecosystem restoration incorporates all types of knowledge and promotes their exchange and integration throughout the process

The evaluation of the projects showed that most of the time, this principle was not well integrated as only some of the projects analysed integrated local knowledge with scientific knowledge. Actions taken towards knowledge integration relate to incorporation of scientific knowledge for evaluation of the restoration, which was then published in peer-reviewed journals; inclusion of local knowledge in meetings during the planning phase; and participation of local communities in the restoration activities. In the Făgăraş Mountains, Romania, local communities participated in reforestation activities, creating a new sense of responsibility and respect (Wilson, Coomes and Dallaire 2019; Hartup, Ockendon and Pettorelli 2022; CARPATHIA 2023).

Principle Seven. Measurable goals: ecosystem restoration is based on well-defined short-, medium- and long-term ecological, cultural and socioeconomic objectives and goals

Most of the projects stated restoration objectives and goals linked to the ecological and socioeconomic context of the ecosystem to be restored. For example, the main objectives of the restoration of grasslands in the Himalayas were the control of extreme soil erosion by setting up natural dams made of biodegradable materials, and the control of livestock production and tourism activities which were the main economic activities being conducted in the ecosystem to be restored. The restoration initiative in Intag, Ecuador aimed to reforest mountains, with the main goal of improving water availability and the conservation of native forests. The project in Ecuador also promoted community-based ecotourism, handicraft production using local natural fibres, and sustainable agricultural activities such as the cultivation of shade-grown coffee (UNDP 2019).

Polylepis saplings grown as part of Acción Andina flagship in Bolivia (Plurinational State of) ©UNEP

Moreover, all restoration projects included measurable indicators of the changes in the ecological and socioeconomic components of the ecosystem as a result of the restoration. For example, the *Polylepis* forest project in the Argentinean Andes considered numerical simulations that specified the magnitude of the desired change to be achieved through the reforestation, taking into account historical information about the forest. The project to restore the *Polylepis* forest in Argentina took 25 years of restoration work and is regarded as the first successful mountain forest restoration in the Andes (Ecosistemas Argentinos 2023; SER 2023). The restoration project of *Polylepis* in Argentina also reported information on the recovery of other ecosystem components, such as the diversity of birds, which is measurable. The restoration project in the Indian Himalayas measured indicators related to the main socioeconomic activities being carried out within the ecosystem to be restored, such as measuring the carrying capacity of livestock production and tourism to produce better management outcomes for grasslands. The project in Ecuador measured indicators related to the number of coffee producers participating in the Association of Intag River Small Coffee Growers, which was created by the NGO DECOIN (UNDP 2019).

Polylepis forest in Ecuador
©Xavier Bravo Guerrero

Principle Eight. Local and land/seascape contexts: ecosystem restoration is tailored to the local ecological, cultural and socioeconomic contexts, while considering the larger landscape or seascape

All restoration projects were tailored to the local, ecological and socioeconomic contexts, but considered a variety of landscape scales. The seascape context was not applicable for the ten mountain restoration projects analysed. Overall, restoration projects covered landscapes on small, intermediate and large scales along elevation gradients. Some projects performed at larger landscape scales considered both ecological and socioeconomic contexts and were aligned with local needs. For instance, the community-based tree planting project in Ecuador covered a large elevation gradient (from 600 to 4 000 m asl) and considered the local needs for water supply and clean water, which are regulated by forests. In addition, the Ecuadorian project also supported ecotourism, organic coffee production and the production of handicrafts and natural products such as soaps and shampoos that were made mainly by women groups and farmer associations (UNDP 2019; Wilson, Coomes and Dallaire 2019). In the Indian Himalayas, the project also recovered medicinal plants, which are important for traditional knowledge and the culture of local communities, and which help to halt the loss of pollinators such as bees and butterflies. The project also held meetings with lowland and adjacent villages to evaluate the feasibility of the project (Kuniyal *et al.* 2021; United Nations Development Programme [UNDP] 2023). In the Carpathian Mountains project, the connectivity of rivers in a large watershed of 644 km^2 was improved, and included the participation of local stakeholders based throughout the area (Mikuś *et al.* 2021).

Principle Nine. **Monitoring and management: ecosystem restoration includes monitoring, evaluation and adaptive management throughout and beyond the lifetime of the project or programme**

Almost none of the selected restoration projects had effective monitoring plans or systems in place to assess on the long-term effects and effectiveness of the restoration on the ecosystem (such as biodiversity, ecosystem health, integrity and human well-being). Although the selected projects contained at least one scientific approach to assess the effects of restoration based on statistically rigorous methods, this is not the case for all mountain restoration initiatives. Indeed, implementing a proper monitoring and evaluation scheme through scientific evaluation is a major challenge for mountain projects, mainly due to the funding required to sustain the long-term monitoring of indicators for ecosystem components, including socioeconomic and cultural impacts (Good and Johnston 2019).

Ensuring adaptive management throughout and beyond the lifetime of the restoration project strongly depends on the monitoring of indicators that enable an objective assessment of the outcomes of restoration.[8] Without adequate monitoring, it is difficult to establish whether restoration activities are genuinely aiding the recovery of the ecosystem's functioning, biodiversity, services, ecosystem health, and human well-being. One notable exception is the restoration of forests and wildfire management in the Colorado Rocky Mountains, USA. This initiative is monitored based on assessments of the ecosystem to be restored following scientific methodologies, which have resulted in a large number of publications, some of which have examined how forests under management and restoration may respond to potential scenarios under climate change. Such an extensive assessment of the effects of restoration will not be possible without the support of a wide variety of programmes, research institutions and organizations, and a strong commitment from government. In the case of the Colorado Rocky Mountains, the knowledge of wildfire management and forest restoration is highly advanced, and out of all the projects analysed, this is the only one that has its own specific restoration principles (Addington *et al.* 2018). The analysis of the Colorado Rocky Mountains also revealed that, aside from broad stakeholder engagement and participation to support monitoring, adequate funding is needed to ensure that monitoring continues throughout and beyond the lifetime of mountain restoration projects.

Mountain biking on Vail Mountain,
United States of America
©Jack Affleck

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[8] Adaptive management is the iterative process of monitoring, evaluating, reflecting and adapting activities and approaches as needed (FAO, *et al.* 2021).

Seedlings grown as part of Acción Andina flagship in Bolivia (Plurinational State of) ©UNEP

Principle Ten. Policy integration: ecosystem restoration is enabled by policies and measures that promote its long-term progress, fostering replication and scaling-up

None of the restoration projects reported clearly on how they were enabled by policies and measures that promoted their long-term progress, or how they contributed to international political commitments and transboundary agreements. Moreover, information on how governance instruments (such as national laws, strategies and policies) were adapted and integrated in the restoration processes is generally scarce. Policies such as protecting wildlife, prohibiting illegal logging, promoting sustainable tourism, and Payments for Ecosystem Services are examples of useful governance instruments that can effectively support mountain restoration projects (Wilson, Coomes and Dallaire 2019; CARPATHIA 2023). The case of the restoration of the Făgăraș Mountains, Romania, falls into this category (CARPATHIA 2023). Additionally, by implementing policies and programmes, governments, NGOs and local communities can create an enabling environment for women's economic empowerment in mountain ecosystems, which is crucial for achieving sustainable and inclusive growth (International Union for Conservation of Nature's Commission on Ecosystem Management [IUCN CEM] and Mountain Ecosystems Specialist Group 2021)

Some projects made considerable efforts to scale up their implementation, an important aspect of Principle Ten. For instance, the restoration of the *Polylepis* forest in the Andes of Argentina started 25 years ago by research scientists has expanded over time to involve local stakeholders and was scaled up by becoming part of the large multi-country regional restoration initiative called *Acción Andina* (Ecosistemas Argentinos 2023; ACCIÓN ANDINA 2023). However, further advances are needed to embed this principle in mountain restoration projects to ensure that the success of such initiatives does not only depend on the actions of project leaders, but also on strong support from government(s) to implement environmental laws, strategies and other governance instruments in mountain restoration projects within their countries and regions.

3

Mountain restoration success stories

Mountains in Kyrgyzstan
©UNEP

Stara Planina Nature Park
©Tourism organization
of Municipality of Knjazevac,
Serbia

As part of their commitments to the **Paris climate agreement**, the **Kunming-Montreal Global Biodiversity Framework**, the **Land Degradation Neutrality targets** and the **Bonn Challenge**, countries around the world have already pledged to revive **1 billion ha** – an area larger than China – by 2030. To learn more about the progress and quality of this restoration, the UN Decade on Ecosystem Restoration put out a call for **World Restoration Flagships** to honour the most ambitious, promising and inspirational examples of making peace with nature, in addition to embodying the ten Restoration Principles of the UN Decade.

The following chapter looks at a selection of mountain restoration success stories that have been shortlisted or selected as World Restoration Flagships from around the world and are being promoted within the context of the UN Decade on Ecosystem Restoration, examining the lessons that can be drawn from each initiative.

The Multi-Country Flagship on Ecosystem Restoration in Mountain Regions

The Multi-Country Flagship on Ecosystem Restoration in Mountain Regions was among the first ten groundbreaking efforts from around the globe to be honoured as a World Restoration Flagship for its pioneering work on large-scale and long-term ecosystem restoration, helping to revive nature. Coordinated by UNEP, the Carpathian Convention and the Mountain Partnership, together with other partners such as Central Asian Mountain Partnership (CAMP) Alatoo, WWF Ukraine, Greater Virunga Transboundary Collaboration and the Great Apes Survival Partnership, this flagship showcases the efforts of national restoration programmes for different mountain ecosystems in Kyrgyzstan, Rwanda, Serbia and Uganda that are expected to help restore more than 2.2 million ha by 2030, and have already led to the restoration of over 1.1 million ha.

> ***FAO, together with UNEP, as co-lead of the UN Decade on Ecosystem Restoration, is pleased to award the ten most ambitious, visionary and promising ecosystem restoration initiatives as 2022 World Restoration Flagships. Inspired by these flagships, we can learn to restore our ecosystems for better production, better nutrition, a better environment and a better life for all, leaving no one behind.***
>
> **QU Dongyu, Director General of FAO**

The various initiatives united under the umbrella of the Multi-Country Mountain Flagship support and address key goals and targets linked to the three so-called Rio Conventions,[9] and also support the Bonn Challenge. The flagship's initiatives achieve this through: the conservation of endangered species and habitats, the establishment of protected areas, biodiversity monitoring, increasing environmental awareness, and combating desertification through reforestation and community-driven pasture management, with all activities underpinned by strong inclusion and the involvement of local communities, women and youth. In addition, besides supporting ecosystem restoration, all initiatives help to develop the capacity and support the livelihoods of often poor and marginalized communities living in mountain areas.

As a result of restoration activities applied so far, the flagship initiative has seen massive achievements in the four countries where it is being implemented (Kyrgyzstan, Rwanda, Serbia and Uganda). In the Virunga Mountains, thanks to the commitments of the governments of the Democratic Republic of the Congo, Rwanda and Uganda, and conservation efforts made by the surrounding communities, the increasing mountain gorilla population has risen to over 1 000 individuals, resulting in a change of the flagship species' status on the International Union for Conservation of Nature (IUCN) Red List from Critically Endangered to Endangered (*Hickey et al.* 2018). In Kyrgyzstan, a rise in the number of snow leopards and ibex – an important source of prey for the snow leopard – has been observed. In Serbia, two parks – Kucaj-Beljanica and Stara Planina – will be upgraded to national park status and have planned programmes that will restore forests and pastures, helping to protect the habitat of the endangered European ground squirrel, and the brown bear.

Restoration methods such as biodiversity conservation, afforestation, agroforestry, forest and pasture management and revitalization, planting of native species, and the removal of invasive species have been used across the flagship's range of ecosystems, including tropical, subtropical and temperate forests and woodlands, shrublands and grasslands. Despite the differences in ecosystems and restoration methodology within the three regions, they are united by commonalities that have been key to their success and have led to the following observations:

1. Integrating Indigenous Peoples' and scientific knowledge through participatory and inclusive processes largely influences the rate of restoration success.

2. Involving local communities in restoration activities is a key factor for effective restoration and acceptance by local communities.

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[9] These are: the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD) and the United Nations Convention to Combat Desertification (UNCCD).

3. Transparency and accountability of information sharing is vital to gain communities' support for restoration activities.

4. Financial sustainability of local livelihoods through the creation of alternative sources of income increases the effectiveness of conservation measures.

5. Incentive mechanisms are important to increase the involvement of local communities until restoration results become visible.

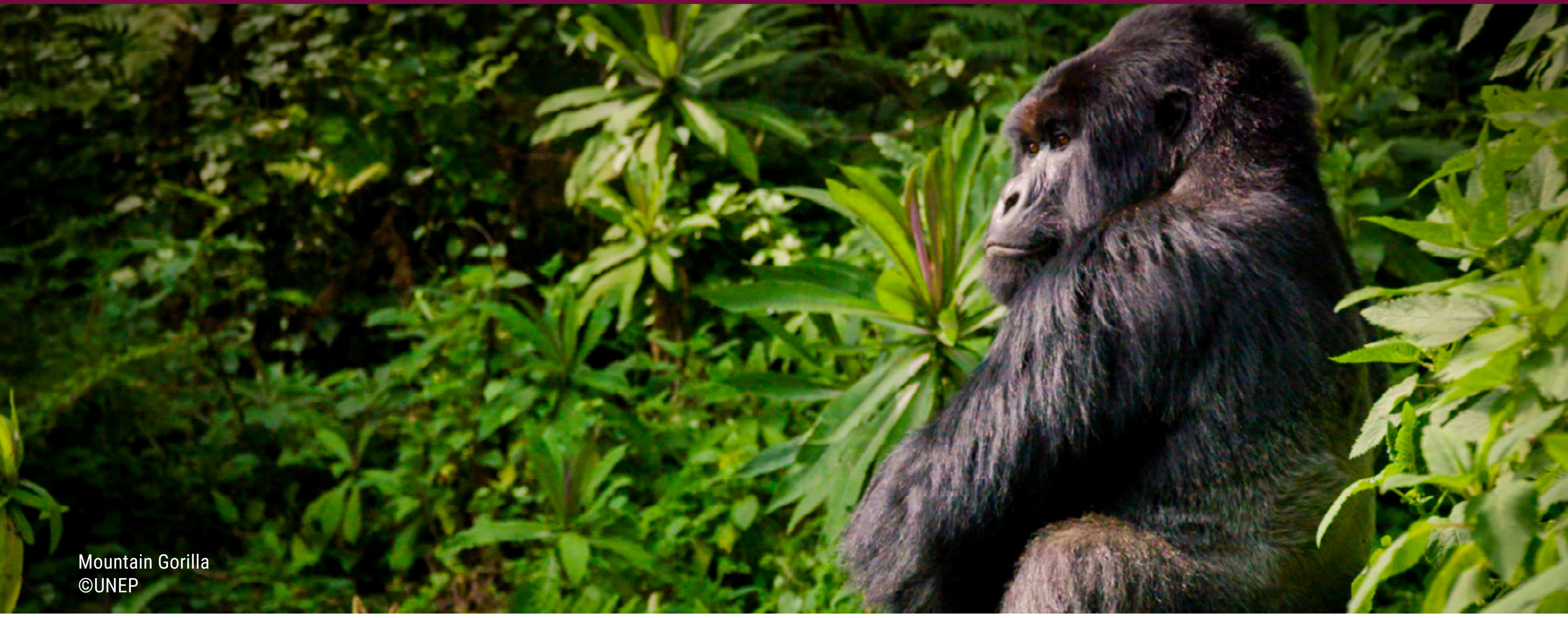
As one of the first UN Decade World Restoration flagship initiatives, the Multi-Country Mountain Flagship has already helped to make restoration solutions for mountain ecosystems more visible, making it easier for them to receive United Nations support, funding and technical expertise. The successes and lessons learned from this flagship can be applied at local, national and regional level, and can serve as inspiration for mountain regions worldwide, including other flagship initiatives that place a focus on mountain restoration.

> ***Mountains are fragile ecosystems where even small changes in climate or tree cover can have devastating effects. As mountain ecosystems and the benefits of their critical services to nature and humanity often stretch across borders, honouring this work in Kyrgyzstan, Rwanda, Serbia and Uganda as part of the inaugural group of World Restoration Flagships should serve as inspiration from what countries can accomplish when they work together to protect these awe-inspiring places.***
>
> **Inger Andersen, Executive Director of UNEP**

The following sections provide a closer look at the restoration initiatives from each region of the Multi-Country Mountain Flagship.

i. Protecting the habitat of mountain gorillas in Rwanda and Uganda

In the southwestern region of Uganda is Mgahinga Gorilla National Park (MGNP). To the south is Volcanoes National Park (VNP) in Rwanda, and to the west is Virunga National Park – Mikeno sector (PNVi-Mikeno) in the Democratic Republic of the Congo. These three mountainous national parks are part of the larger Virunga Massif, covering 342 km^2 and lie between 3 474 and 4 507 metres above sea level. MGNP was declared a national park in 1991 and is currently earmarked for elevation to a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site status, due to its unique scientific and cultural values that are of global importance. It covers an area of 33.7 km^2. VNP, covering an area of 160 km^2, was declared a national park in 1925 and was classified by UNESCO as a biosphere reserve in 1983. The Virunga Massif is home to more than half of the remaining global population of endangered mountain gorillas (*Hickey et al.* 2019).


Mountain Gorilla
©UNEP

Critical values for MGNP and VNP include, but are not limited to, rich biodiversity in fauna, such as mountain gorillas, golden monkeys, elephants, giant forest hogs, bushbucks and buffalos. The Virunga Massif has a richly diverse montane flora and critical water catchments (montane swamps), and holds aesthetic value thanks to its volcanic mountains, craters, crater lakes and caves.

The area around the Virunga Massif is characterized by a high human population density of ≥600 people per km^2, mainly due to the rich volcanic soils that support subsistence agriculture. As a result of increased human population and the subsequent need for farming to produce sufficient food and income to support human well-being, VNP and MGNP were first encroached on in the 1950s, with evictions taking place only later in the 1990s. In addition, forest habitat degradation has been attributed to the invasive species Mountain Alder (*Alnus viridis*), whose seeds spread by wind dispersal and which suppresses vegetation undergrowth at MGNP. Indeed, invasive plant species have contributed to habitat degradation in both parks, outcompeting native species and reducing the diversity of natural plant communities, resulting in an overall negative impact on biodiversity. However, as a result of restoration efforts in both national parks, native wildlife is making a comeback and local communities are experiencing a range of benefits.

Mgahinga Gorilla National Park, Uganda

Non-native tree species were introduced to Mgahinga Gorilla National Park before 1989, as a result of massive encroachment by farmers in some areas of the park while it was still a forest reserve. Farmers brought with them tree species such as *Eucalyptus spp.*, black wattle (*Acacia mearnsii*) and others which are non-native from their former gardens. These tree species have since multiplied and colonized extensive areas. In addition, as part of an agroforestry intervention originally intended for soil fertility improvement, farmers in Rwanda whose land borders MGNP planted the invasive tree species mountain alder (*Alnus viridis*). This tree has spread extensively over the years through wind-aided seed dispersal into the adjacent zone of the MGNP. Due to the ability of these invasive species to invade the habitats of indigenous species and outcompete them, the result has been severe degradation of habitats, negatively affecting the foraging patterns of wildlife; most of the invasive species are not palatable and they generally suppress the growth of native undergrowth and herbage. Working with the International Gorilla Conservation Programme (IGCP), Fauna and Flora International, and communities located around the edges of MGNP, a total of 61 ha had been cleared of invasive plant species as of July 2023 to allow natural regeneration. This was done in the areas of Rucantegye, Nyabyiyoni Nyagisenyi, Nyamuhamba and Nkanda. The removed tree species included green alder (*Alnus viridis*), with both older trees and seedlings being uprooted. Eucalyptus trees and black wattle, as well as other tree species, were also debarked as a method to help control their spread. A further 40 ha were due to be cleared in late 2023. Moses Turinawe, the Warden in Charge, said that the challenge of invasive plants at MGNP is still complex despite the efforts made to remove them. He explained that the seed of green alder is blown by wind from farms owned by neighbouring communities in Rwanda and germinates in the already cleared areas. Moses added that such a transboundary issue needs to be approached through the Greater Virunga Transboundary Collaboration (GVTC), a regional body that is mandated to handle issues of this nature.

Volcanoes National Park
©UNEP

Volcanoes National Park, Rwanda

Restoration of habitats at Volcanoes National Park (VNP) has been carried out by park edge communities through the removal of invasive tree and shrub species, as well as of non-biodegradable materials left behind by humans. The invasive plants at VNP are believed to have been dispersed by a combination of wildlife, livestock and humans during the time that the park was encroached on. Soda apple (*Solanum aculeastrum*) and Mountain Papaya (*Vasconcellea pubescens*) are examples of invasive species that were outcompeting native plants in VNP. The invasive plants at VNP were most common in areas of Nyagahinga, Kanyirarebe, Kagano, Kinigi and Nyamurimirwa. An estimated 3 000 ha have now been restored in the national park, with support from IGCP and the Rwanda Development Board. According to Benjamin Mugabukumeye, IGCP Country Coordinator in Rwanda: “The removal of invasive plants has created the much-needed space for indigenous plants to regenerate, thereby improving the quality of habitat for mountain gorillas.”

Controlling the colonization capacity of invasive plant species in both MGNP and VNP has contributed to conserving biological diversity and creating space for more undergrowth, to enable wildlife to thrive. Close involvement of communities bordering both parks, such as in restoration work, has helped them to benefit from the wages and has turned them away from poaching. These efforts and more have helped to protect the habitat of mountain gorillas, which in turn has resulted in the population almost doubling in the past 30 years (Hickey et al. 2018). Much of this success has depended on the commitment of the three state governments and local communities participating in and benefiting from the efforts made to ensure ecological growth and restoration.

Stara Planina Nature Park
©Tourism organization
of Municipality of Knjazevac, Serbia

ii. Brown bears return to the forests of Stara planina and Kucaj-Beljanica, Serbia

In the eastern part of Serbia, a remarkable initiative is under way to revitalize the natural landscapes that have been cherished for generations. In Stara Planina Nature Park and Kucaj-Beljanica, significant efforts are being made to expand tree cover and restore valuable pastures. This ambitious project not only promises to bolster the ecosystems that have endured the scars of wildfires, but also serves as a beacon of hope for many species that live there.

The restoration activities have generated success stories that resonate with the spirit of renewal. Among the most captivating achievements is the return of the brown bear to the forests of Stara Planina. Throughout history, there is written evidence about the existence of a large community of brown bears (*Ursus arctos*) in Stara Planina Nature Park and the wider Carpathian and Balkan area in Serbia. These testimonies date from the nineteenth century. The number of brown bears had been in sharp decline, and by the end of the 1970s the population had vanished. After an absence spanning decades, two individuals ventured back into these woods, making their first appearance in 2013. Since then, their presence has been regularly documented, and the population has shown an increase to 3–5 bears. In the wider surrounding area, including Kucaj Beljanica, there are now about 10 individuals. These brown bears, originating from Bulgaria, have settled in Serbia's Stara Planina Nature Park, where they have found refuge and an opportunity to thrive.

The journey towards restoration began after a devastating forest fire in 2007, which engulfed some 1 500 ha of woodland in the vicinity of Zavoj Lake. Soon after, an unwavering commitment to rehabilitation took root. Year by year, a systematic approach to restoration has expanded, supported by strategic reforestation measures implemented by management company Srbijasume. Since 2019, in Stara Planina Nature Park, around 20–30 ha have been restored. In addition, since 2010, around 200 ha have been reforested. The results have been tangible, with the damaged landscape gradually being transformed into a flagship of restoration.

Kucaj-Beljanica, a biodiversity-rich hotspot, now hosts a number of important species, including the European lynx (*lynx lynx*) and Chamois (*Rupicapra Rupicapra*). An expert from the Institute for Nature Protection of Serbia, Vladan Bjedov, says there are currently approximately 60 individuals of European lynx in Kucaj-Beljanica and the wider Carpathian area in Serbia.

The restoration efforts in both parks have led to the emergence of renewed harmony between species within the ecosystem. Brown bears in both parks are now settled within the rehabilitated forests, amidst the now resilient flora and fauna. The waters of Stara Planina Nature Park are abundant with trout, presenting an attractive meal for the returning brown bears; these same fish, and the clear waters in which they swim, have helped to entice various avian species to reclaim their territories, including golden eagles and cormorants. As the forest reaches maturity, many benefits from ecosystem services are expected to benefit local communities.

However, the journey of restoration is far from complete. A plan to reforest 200 ha and revitalize 30 ha of pastures in Stara Planina Nature Park and Kucaj-Beljanica by 2030, stands as testament to the unwavering commitment to restoring these lands to a rich and healthy habitat.

Wildflowers in Stara Planina Nature Park, Serbia
©Tourism organization
of Municipality of Knjazevac, Serbia

Horses in Kyrgyz mountains
©UNEP

iii. Snow leopard populations increase in Kyrgyzstan

In Kyrgyzstan's mountainous regions, a significant shift in perspective has occurred among local communities regarding the value and importance of environmental conservation. This change prompted residents from three distinct rural areas within the Issyk-Kul region to establish a public micro-reserve, Baiboosun.

Launched in 2019, the Baiboosun micro-reserve, covering 14 000 ha of pastures and glaciers, was created in collaboration with the NGO CAMP Alatoo. Following consultations with local communities and authorities, the protected zone was established, and strict regulations on activities such as hunting, grazing and botanical extraction were implemented. As Baiboosun represents an initial attempt at establishing a community-based micro-reserve, this experience is serving as a foundation for proposing necessary changes to the current legislation. Currently, the micro-reserve operates under the support of local authorities as a community-based micro-reserve.

The primary objective of the Baiboosun micro-reserve is to conserve fauna and flora, with a focus on restoring populations of both. This objective is strongly supported by residents who aim to conserve the region's biodiversity. Their support is in alignment with scientific research conducted by the Kyrgyz Academy of Sciences, which has confirmed the ecological significance of the reserve. The reserve hosts a diverse range of species, including 18 mammalian, 60 bird, and over 500 botanical species, some of which are registered in the Red Book of Kyrgyzstan, a list of the country's endangered fauna and flora, and on the Red List of the International Union for Conservation of Nature.

Enthusiastic local stakeholders have accepted responsibility for protecting this rich biodiversity. People previously engaged in hunting and fishing activities have undergone specialized training to transition to community rangers. Local residents have been offered alternative economic opportunities to make up for this change in income. These include organizing guest houses for tourists, starting cheese production among a group of women, and crafting

Snow leopard cub
(camera trap shot)
©CAMP Alatoo

souvenirs from felt. Additionally, a group of residents has been cultivating sea buckthorn trees along the riverbanks, which also helps with bank stabilization. To support these initiatives, interested individuals have received training and startup capital grants.

To ensure long-term sustainability, CAMP Alatoo is actively working on establishing a local revolving fund that will finance economic activities unrelated to ecosystem stress. Simultaneously, the NGO is working on developing relevant national-level by-laws to upscale its valuable experiences throughout the country.

Baatyrbek Akmatov, a director of PF Baiboosun Nature Reserve and a committed advocate for the conservation cause, briefly summarizes this transformation: "We took the first step and created a special reserve to preserve and protect our nature. If not us, who will have a heartache for these uniquely beautiful places? That's why all local residents supported this idea – to make a valuable gift to future generations."

The efforts of the rangers include patrolling the protected area, managing and relocating camera traps to monitor wildlife dynamics. Notably, the elusive snow leopard population has shown signs of increasing its numbers within the reserve, with four adults and four cubs spotted using camera traps.

The environment in the reserve provides an ideal habitat for the snow leopard and has also contributed to an increase in other species. The ibex population, for instance, has grown from 97 to 240 individuals in just four years, as a result of improved pasture quality and grazing practices.

Scientific expedition exploring the micro-reserve territory ©CAMP Alatoo

Local shepherds, guided by CAMP Alatoo, have adopted modern grazing techniques that have led to enhanced vegetation cover and pastureland vitality. Spanning 18 000 ha, this designated pasture zone is managed through rotational grazing practices. The technique involves the cyclical shifting of grazing plots, resulting in accelerated recuperation of vegetation cover and ultimately enhancing the overall vitality of the pastureland.

In addition, Argentinian artist Luciano Foglia, a designer whose dedication was kindled during a year-long volunteering tenure, has played an unexpected role in the reserve's conservation efforts. Intrigued by the abundance of camera trap documentation, he established the website **www.baiboosun.com** to raise awareness of wildlife conservation in the region. This aligns with the belief that localized empowerment is of paramount importance for sustainable transformation.

Aside from its ecological achievements, the Baiboosun micro-reserve has catalysed transformation within the local community, promoting the emergence of sustainable tourism and ecologically sensitive infrastructure and enterprises. Yurt settlements, organic products, nature trails and horse-riding have become attractions for visitors seeking environmentally-friendly experiences. As the community works to safeguard its heritage, the connection between people and the natural environment continues to deepen, promising a solid legacy for the future.

Rangers during the micro-reserve area patrol ©CAMP Alatoo

Acción Andina

The high Andean mountains are home to rich forest ecosystems that sustain diverse wildlife and hundreds of millions of people across South America. Freshwater captured by these forests reaches nearby villages and cities, while feeding into the headwaters of the Amazon. However, climate change has accelerated glacial melt and centuries of deforestation have reduced high Andean native forests to just 3-10 percent of their original extent. Not only does this put communities at risk of severe water insecurity, it also disproportionately affects the most vulnerable – the people of the high Andes and their unique indigenous culture.

Jointly launched in 2018 by Global Forest Generation and Asociación Ecosistemas Andinos (ECOAN), Acción Andina aims to protect and restore 1 million ha of critical high Andean, native *Polylepis* forest ecosystems over the next two decades, spanning the seven Andean countries – Argentina, the Bolivarian Republic of Venezuela, Chile, Colombia, Ecuador, Peru and the Plurinational State of Bolivia. It is the first multi-country, large-scale initiative to restore high altitude, native forests in this region of the world.

Acción Andina was shaped by the community reforestation model of indigenous Peruvian conservation leader and President of ECOAN, Constantino (Tino) Aucca. Together with restoration partners, this 2022 recipient of the United Nations' Champion of the Earth award for Inspiration and Action is reviving the ancient Inca principles of *Ayni* (reciprocity) and *Minka* (communal service), while integrating modern, targeted support and technology. By bringing large numbers of conservation organizations together under a common framework and philosophy, Acción Andina has significantly improved project quality, efficiency and sustainability.

According to Aucca, involving communities is essential to any successful conservation effort. "Working all together (donors, partners, local communities, volunteers, etc.) and reviving ancient practices to achieve our mission, we seek to be in equilibrium with the environment," he says. "Acción Andina will plant millions of native trees along the Andes, to secure water, landscapes and protect the ecosystems, biodiversity and culture."

To date, Acción Andina has planted more than 6.5 million native trees and reforested 3 359 ha of high Andean forests. Most partners intersperse a mix of native species among the dominant *Polylepis* species, with plantings generally taking place during the Andean rainy season, between October and March. Additionally, 11 253 ha of native forests have received protection through eight new or renewed protected areas. During the 2022–2023 season alone, the project trained and supported 21 on-the-ground restoration leaders and 83 nursery technicians. The benefits of Acción Andina's restoration and conservation efforts are multiple: climate resilience, water security and improved habitats for native species, such as the Andean condor and the spectacled bear.

Yet Acción Andina's successes go far beyond such numbers. The project has united tens of thousands of people – many previously excluded from conservation efforts – to collectively restore their forests. Tree by tree, the people involved in Acción Andina are creating more resilient landscapes and communities in the face of a warming world.

Women planting *Polylepis* trees in the Andes
©Wade Million/Acción Andina

Florent Kaiser, CEO of Global Forest Generation and co-lead of Acción Andina, says that realizing one of the largest community-driven conservation initiatives in South America will require continued investment and vision:

> **Ecosystems take time to heal, so if we're really serious about restoring natural systems, then we need to ensure the long-term sustainability of our initiative. As a key force behind the success of Acción Andina, Global Forest Generation is poised to grow our efforts globally and continue building strategic partnerships with government, companies, financiers, civil society and others.**

Florent Kaiser, CEO of Global Forest Generation

The Terai Arc Landscape initiative

Launched in 2001, the Terai Arc Landscape initiative aims to create contiguous habitats connecting transboundary natural ecosystems in India and Nepal, minimizing rapid forest loss and fragmentation. In Nepal, the Terai Arc Landscape covers 2.47 million ha of land – mainly fertile lowland in the south and fragile hills in the north. The landscape covers various land uses such as protected areas, forests, wetlands, agricultural lands and settlements. The Terai Arc Landscape hosts metapopulations of Bengal tigers, Asiatic elephants and one-horned rhinoceroses, and it remains a critical habitat for 565 species of birds, 125 species of fish, 85 mammal species and 47 reptile species. More than 7.5 million people reside in the Terai Arc Landscape, benefiting from the ecosystem services of their surroundings, as well as those upstream from the Hindu-Kush Himalayas. A ten-year strategic plan was developed by the Government of Nepal in 2004. This was revised in 2015, with a vision of generating a "a globally unique landscape where biodiversity is conserved, ecological integrity is safeguarded, and sustainable livelihoods of its people are secured".

Tiger caught on camera trap in Nepal
©DoFSC WWF Nepal

WWF Nepal launched the Terai Arc Landscape initiative in partnership with the Government of Nepal. It mobilized local communities and stakeholders for the effective management and restoration of critical corridors within the landscape, so as to create and maintain ecological connectivity, linking protected areas with other conservation-friendly land uses. Forest landscape restoration has been one of the priority interventions of the Terai Arc Landscape programme, with efforts mainly focused on restoring deforested areas, degraded lands, and river floodplains, particularly in the ecological corridors. A two-pronged strategy involving replanting trees and promoting natural regeneration has been adopted to restore degraded lands.

Major outcomes and benefits achieved in the Terai Arc Landscape during the past two decades have included an expansion of forest area, an increase in populations of endangered species, and greater conservation benefits for local communities. Forest area grew from 1.28 million ha in 2001 to 1.35 million ha in 2016, with a net forest gain of 66 800 ha. This gain was mainly achieved by forest restoration and forest protection through community-based forest management, where planting of indigenous species and natural regeneration have been promoted, considering biodiversity and ecosystem services. Together, forest protection, restoration and community-based forest management have contributed to an increase in tiger and rhinoceros populations. The tiger population nearly tripled in the space of just over ten years, from 121 in 2009 to 355 in 2022, while the rhinoceros population more than doubled from 372 in 2005 to 792 in 2021. Restored corridors also have a hydrological function, as water springs have reappeared and wildlife movement has increased.

Local communities have experienced tangible benefits, including improved livelihood opportunities through forest- and farm-based green enterprises and nature-based tourism. During the last decade, a total of 2 298 households have initiated small-scale forest- and farm-based enterprises, selling essential oils, brooms (made from broom grass and used for sweeping) and juices (produced from fruits of the forest). Some 132 households now run homestays and secure revenues from nature-based tourism. Importantly, local communities have launched cooperatives to manage community capital, which is created through a revolving fund consisting of contributions from The World Wide Fund for Nature (WWF) and communities' own savings. Approximately USD 4.9 million of community capital has been mobilized from 114 cooperatives and is used to improve the livelihoods and socioeconomic well-being of local people.

The success of the landscape approach in the Terai Arc Landscape has been achieved through multistakeholder engagement involving government leadership, community stewardship and civil society support.

Terai Arc Landscape forest
©Ananta Bhandari/WWF Nepal

The passage to the Amazon in Atillo, Ecuador
©Patricio Mena Vásconez

4

Initial recommendations on how best mountain restoration practices and the Ten UN Restoration Principles can be applied to account for the inherent needs of mountain ecosystems

Snow leopard caught on a camera trap
©UNEP

The following section provides initial recommendations emerging from the review of the case studies and is aimed to facilitate a reflection by the ecosystem restoration community on how the United Nations Decade on Ecosystem Restoration's Ten Principles of Ecosystem Restoration could be incorporated into initiatives for the recovery of mountain ecosystems, to account for the specific needs of mountain ecosystems. Although useful in furthering the probable impact of mountain restoration projects and ensuring their alignment with the Ten Principles of Ecosystem Restoration, these suggestions represent a small fraction of what can be achieved, because the main outcomes of any restoration initiative will depend on how the project starts and changes over time, as well as the specific context of the mountain ecosystem to be restored.

Principle One: Mountain ecosystem restoration projects at all spatial scales can contribute to the achievement of the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs) and also support the goals of the UN Rio Conventions.

The context of the mountain ecosystem being restored will influence which SDGs the project relates to, and to which of them they will contribute. Whenever relevant, mountain ecosystem restoration projects might focus their contribution to those SDGs whose targets are related to mountains, such as: SDG 6.6 on the protection and restoration of water-related ecosystems, including mountains, forest, wetlands, rivers, aquifers and lakes; SDG 13.1 on strengthening resilience and adaptive capacity to climate-related hazards and natural disasters in all countries; SDG 13.2 on integrating climate change measures into national policies, strategies and planning; SDG 13.3 on improving education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning; SDG 15.1, which relates to the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and services; SDG

15.4, which relates to the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development; SDG 15.4.1, which is related to coverage by protected areas of important sites for mountain biodiversity; and SDG 15.4.2, which is the Mountain Green Cover Index.[10]

Principle Two: Mountain ecosystem restoration projects promote broad public participation and engagement, including with women and minority groups. Particularly, mountain restoration projects aim to provide equal opportunities to all stakeholders living at the specific site to be restored, encouraging them to participate in all phases of the initiative.

Promoting broad public participation and engaging stakeholders in the restoration site, as well as in the areas involved along the elevational gradient, is an important way of understanding local needs, including cultural, educational and socioeconomic contexts. It can also help to identify, among others, the effects of land degradation on local communities; avoid potential conflicts and negative impacts on the livelihoods of lowland and upland local communities during the restoration process, in particular with local communities that are isolated because of the mountain topography; anticipate potential solutions to unexpected outcomes; guarantee the transparency of the restoration process; and ensure the long-term participation of local communities.

Embedding this principle would also require documenting how the dialogue, trust and mutual respect among local communities and stakeholders was developed, and whether this was achieved through inclusive, equitable, socially fair and transparent governance, with mechanisms for impartial conflict resolution and fair benefit-sharing in place.

Principle Three: Mountain restoration projects do not cause negative effects to other components of the mountain system, such as society, livelihoods, culture, education, human well-being, biodiversity, ecosystem functions and services, and ecosystem health and integrity.

Methods used in mountain ecosystem restoration projects aim to promote the natural recovery of the type of ecosystem to be restored. In particular, restoration methods applied after landslides and the construction of infrastructure (such as ski, mining and water infrastructures) promote the natural recovery of native species and support good soil management practices. Good restoration practices in mountains may also include restoring populations of endangered animals on the IUCN's Red Books and Red Lists by establishing protected areas as a mechanism to help control the drivers of degradation and facilitate the recovery of mountain ecosystems.

Good restoration practices exclude the use of materials that can damage the ecosystems such as devices that contain toxic metals. Instead, restoration projects should use local and biodegradable materials where possible. To restore freshwater ecosystems (such as through improving river connectivity), restoration projects could benefit from the use of natural infrastructure and from policies for lowering dams or removing obsolete dams.

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[10] The Mountain Green Cover Index measures changes in the area of green cover in mountain areas. The assumption is that green cover is directly correlated with the health state of mountain ecosystems.

Consideration of the specific climatic and environmental conditions of mountains, in particular those of ecosystems that are subject to extreme environmental conditions and soils that are highly sensitive to erosion, is an important element of restoration. The use of local genetic materials that are already adapted to local environmental conditions (such as native seeds collected from a nearby area) is encouraged, as it often increases the chances of the effective establishment of species at the mountain site.

Massive afforestation in mountains with non-native species has potentially negative effects on water supply in mountains and downstream, as well as other impacts, such as discouraging the growth of local vegetation and their potential to be invasive. In addition, the careful management of fertilizers reduces the risk of creating suitable conditions for the establishment of invasive plants along the elevational gradient that challenge the restoration process and affect other mountain ecosystems.

Methods for controlling invasive species in mountains that include clear-cutting, thinning and manual extraction should be well planned and regulated by the respective national authorities and institutions.

Principle Four: Mountain ecosystem restoration activities result in net gain for biodiversity, ecosystem health, integrity, connectivity, resilience and human well-being across elevational gradients and watersheds.

Mountain restoration activities promote the natural recovery of a variety of ecosystems and benefit native species that were not observed to cause ecological damage, minimizing the occurrence, abundance and upslope dispersion of invasive species (i.e. passive and active dispersion). They also eliminate the impacts of invasive species on ecosystem services, such as water supply to lowland sites and the suppression of native grassland species that are of high value for the livelihoods of local communities.

Principle Five: Mountain restoration initiatives consider all causes of degradation and the magnitude of degradation, anticipate potential responses of the ecosystem to the restoration, and seek to control, minimize or eliminate the drivers of degradation during restoration.

During the planning phase, mountain ecosystem restoration projects will set a baseline of the type of ecosystem to be restored, so as to better understand, identify and address the direct and indirect causes of degradation.[11] Baselines should contain as much information as possible about the ecosystem to be restored (such as historical and current information). Baselines should also include an analysis of the magnitude of the degradation, the factors causing degradation along the elevational gradient, the potential of ecosystems for natural regeneration, and the limitations of any restoration initiative.

Restoration projects will develop a plan to control the drivers of degradation and to reduce the negative synergistic effects with climate change in mountains. For instance, increased water evaporation caused by increases in air temperature due to climate change can increase the concentration of toxic metals in water. Eliminating the discharge of pollutants in freshwater ecosystems is an effective restoration activity that helps to reduce the effects

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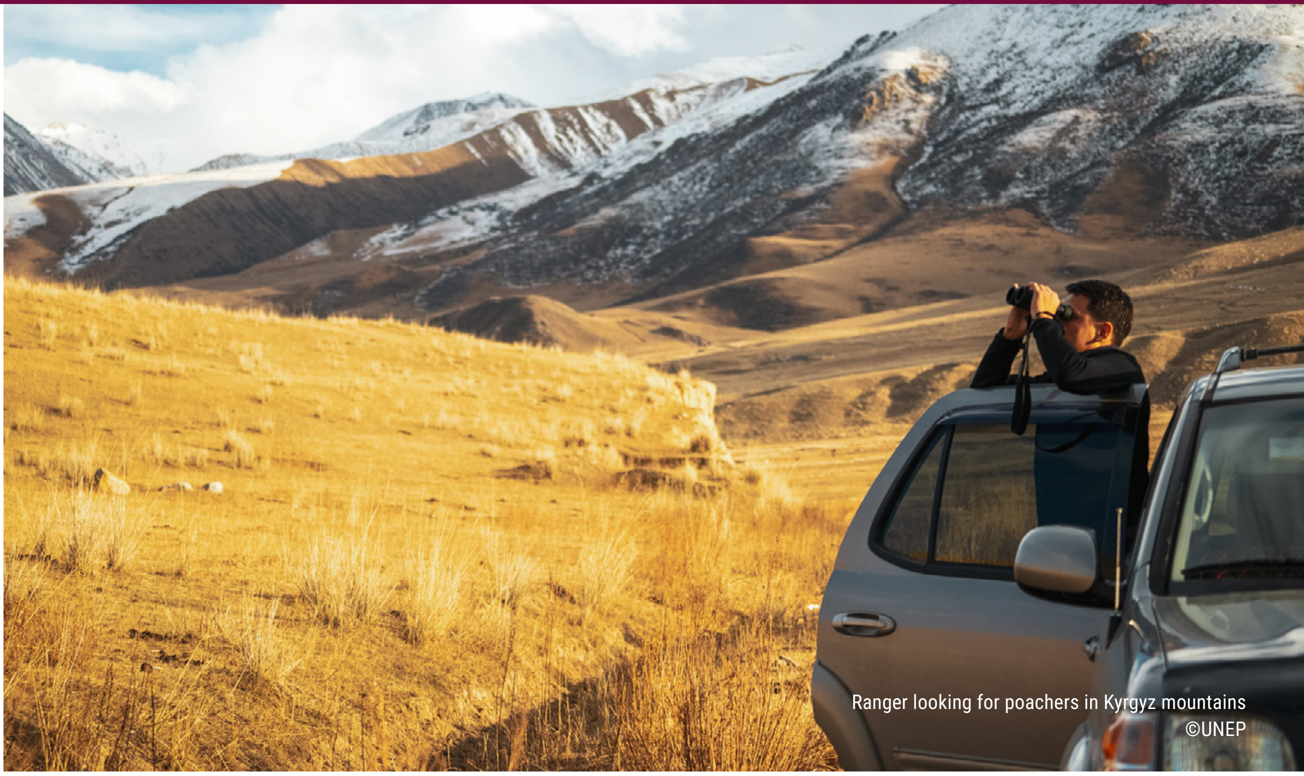
[11] A baseline is a key concept in ecosystem restoration. Overall, it refers to site assessment prior to the restoration. The two main concepts are baseline condition and baseline inventory. For mor information on baselines for ecosystem restoration, see International principles and standards for the practice of ecological restoration (Gann *et al.* 2019).



Ranger looking for poachers in Kyrgyz mountains
©UNEP

of climate change on mountain water resources. In addition, the analysis of how to address land-use and property regimes that cause degradation and ultimately impede the long-term permanence of restored ecosystems plays an important role in the restoration process, together with developing consultations with local communities and seeking the support of local authorities to effectively control drivers of degradation.

Taking into account the current trends of warming in mountain regions and their associated impacts, which can challenge restoration efforts (for example, the presence of invasive species at elevation), the outcomes of the restoration projects are improved by including predictions of the response of the ecosystem under restoration, considering climate change scenarios, and identifying potential adaptation measures to increase resilience.

Principle Six: Mountain ecosystem restoration projects integrate all kinds of knowledge related to the ecosystem to be restored, including scientific and local knowledge, and the best mountain ecosystem management practices from stakeholders, local communities, citizens and Indigenous Peoples who live at the site to be restored, or along the elevational gradients of the mountain area.

Integrating the knowledge of local communities helps to identify previous successful and unsuccessful restoration activities, in order to implement the best possible restoration practices. It also helps to deepen understanding of the prior state of the ecosystem before degradation occurred, and to recognize potential ecosystems of reference in the nearby area, supporting decisions regarding the desired level of restoration to be achieved and identifying useful indicators for the monitoring and evaluation of the restoration.

Obtaining free, prior and informed consent regarding the use of traditional and Indigenous Peoples' knowledge is at the core of this principle. Documenting and communicating the process of knowledge integration, which includes co-creation, integration, mutual learning and respect for the consultation process of local and indigenous communities allows the identification and replication of good practices in this regard. Restoration projects could also document the sustainable solutions and climate change adaptation strategies that local and indigenous communities have created to cope with the challenges of living in isolated mountain areas.

Principle Seven: The objectives and goals of restoration initiatives in mountains, along with their related indicators, include the ecological, socioeconomic, cultural and educational needs of people living along the elevational gradients.

Indicators enable the assessment of the success and extent of the restoration compared with the baseline. Restoration objectives and goals may take into account the historical, current and future state of the mountain ecosystem to be restored. Historical and current information makes it possible to anticipate the potential responses of the ecosystem to future anthropogenic and climate disturbances.

Principle Eight: Mountain ecosystem restoration projects can be undertaken at a variety of landscape scales, and along different elevational gradients.

A robust understanding of the context of the ecosystem to be restored in the case of larger landscapes is essential to avoid unwanted impacts or conflicts with local inhabitants. Spatial planning processes may help in this sense to support mountain restoration projects at larger spatial scales, guarantee the landscape connectivity and resilience of terrestrial and freshwater ecosystems along the elevational gradient or watersheds, and maximize ecosystem recovery.

Capricorn (camera trap shot)
©CAMP Alatoo

Consideration of the dispersion of species along elevational gradients plays an important role in maintaining the interconnectedness of mountain ecosystems.

Watershed or basin scales are applicable to mountains for the recovery of rivers that might include their physico-chemical, biological and hydrological conditions. For example, plans to control the degradation of rivers (such as water contamination) are best implemented at the watershed scale because contamination can be transported across the whole watershed by the natural flow of rivers.

Projects applied on smaller landscape scales can be developed by individuals or small groups of researchers or organizations and can have successful outcomes (such as the case of restoration in the Argentinian Andes). They can make a valuable contribution over time to increasing the surface area of land restored, the number of partners and local inhabitants involved, and – with the support of NGOs and governmental institutions – to the overall impact of restoration.

Principle Nine: Adequate funding is critical to sustain monitoring, evaluation and adaptive management of mountain restoration projects over time.

Mobilizing economical resources from governments, NGOs, the private sector and other sources is crucial to assess the outcomes of the restoration projects, based on a statistically rigorous approach with the support of research institutions. Adaptive management enables continual improvement and learning processes and promotes social learning and the engagement of mountain communities in the monitoring of projects. A final evaluation assesses what worked or failed and communicates lessons learned to improve future restoration project designs.

Principle Ten: Co-management of initiatives between NGOs and local communities to set up restoration projects and establish protected areas are examples of good governance instruments that can be replicated in mountain restoration projects.

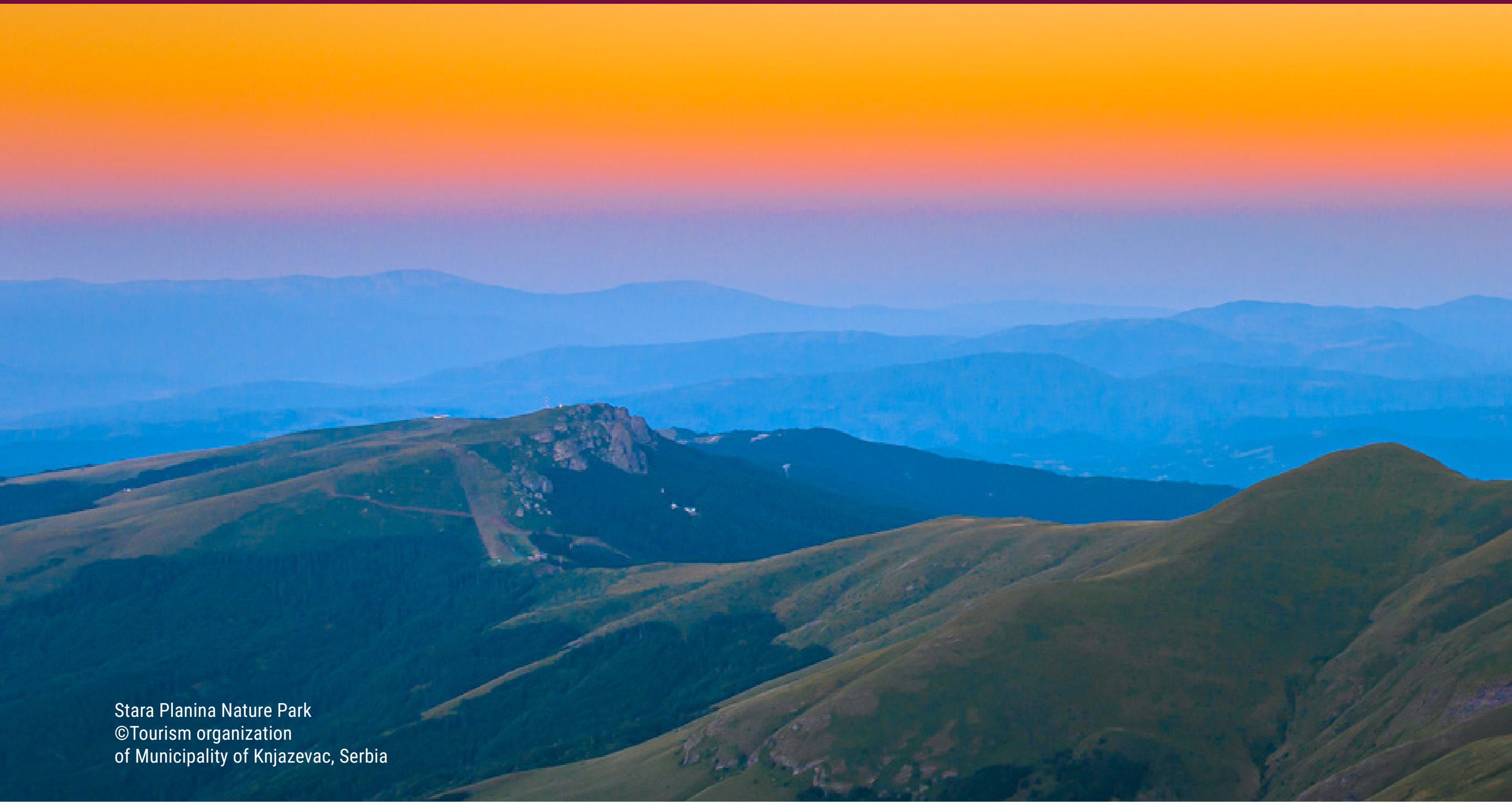
Payments for Ecosystem Services can be useful policy instruments in support of restoration in mountains, so long as the funding is sustainable in the long term and does not risk affecting the livelihoods, security, culture or human rights of any stakeholders living in and around the mountain ecosystem to be restored, or provoke any conflicts of interest.

Since mountain ecosystems are largely transboundary and span different countries, restoration activities benefit from synergies with regional governance mechanisms, such as the Alpine Convention, Carpathian Convention and the Andean Mountain Initiative, as well as tools to enable the out- and up-scaling of activities. Multi-scale knowledge networks on the national, regional and global level can play important roles in supporting and coordinating restoration actions at regional and interregional scales.

Restoration flagship project in Kyrgyzstan
©UNEP

5

Conclusions



Stara Planina Nature Park
©Tourism organization
of Municipality of Knjazevac, Serbia

Healthy, conserved mountain ecosystems provide vital services to the planet, help to mitigate and promote adaptation to climate change, prevent erosion, and reduce the risk of natural disasters such as avalanches, landslides and floods. Restored mountain ecosystems support the well-being and livelihoods of mountain people and billions of inhabitants in connected lowland areas.

To halt, prevent and reverse the degradation of ecosystems and restore these in order to achieve the global goals of the 2030 Agenda for Sustainable Development, partners of the United Nations Decade on Ecosystem Restoration developed a set of ten principles that underpin all restoration activities. The aim is to create a shared vision of ecosystem restoration and ultimately support implementation of the Decade, contributing to a better environment and a better life for all, leaving no one behind. Mountain ecosystem restoration projects should align themselves with the Ten Principles of Ecosystem Restoration, to further their impact and ensure the highest level of natural recovery.

Mountain ecosystem restoration is both effective and possible. Some countries have already celebrated tangible successes in restoring mountain ecosystems: Rwanda and Uganda have managed to almost double the number of mountain gorillas in the past 30 years, generating welcome revenue from tourism for authorities and communities in poor and densely populated areas next to the parks; Kyrgyzstan is seeing snow leopards return in the Baiboosun micro-reserve, along with the emergence of sustainable tourism and ecologically-sensitive infrastructure and enterprises; in Serbia, the brown bear is finding new habitats thanks to efforts to expand tree cover and restore valuable pastures; in the Andes, conservation efforts are contributing to climate resilience, water security and improved habitats for the Andean condor and the spectacled bear; and in Nepal, tiger and rhinoceros populations are rising, while livelihood opportunities are simultaneously being improved through forest- and farm-based green enterprises and nature-based tourism. Restoration efforts have also helped to create new jobs in rural economies. In recognition of these achievements, the countries' efforts have been acknowledged under the umbrella of the UN Decade World Restoration Flagships.

People living in mountains are at the heart of mountain restoration, and their involvement is the key to success. Immediate action with an inclusive approach is needed to support climate change adaption and halt ecosystem degradation, pollution and biodiversity loss in mountains. Empowering, recognizing and involving Indigenous Peoples, women, youth and local communities in decision-making processes is crucial for enabling sustainable mountain development and building resilience in these vulnerable ecosystems. Their traditional knowledge and practices contribute to biodiversity conservation and resilient land management. Taking gender-responsive and socially inclusive approaches are fundamental for achieving long-term ecological and social sustainability.

Major challenges that inhibit the regeneration of mountain ecosystems remain, including limited funding, policy gaps, limited exchange and development of best practices, and insufficient monitoring and data. The strong support of governments, civil society and the private sector is essential to ensure and scale up adequate nature-positive investments, connect policy agendas and actions for mountains, boost regional coordination, and implement the Five Years of Action for the Development of Mountain Regions' global framework for action.

Mountains are not just majestic landscapes; they are lifelines for billions of people. In the face of climate change, biodiversity loss, and pollution and waste, it is a global responsibility to protect mountain ecosystems. The future of food security, clean freshwater supply, and biodiversity depends on the collective efforts of everyone, including government, civil society and the private sector.

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Restoring mountain ecosystems

Mountains are home to a variety of ecosystems that provide vital services directly to 1.1 billion people and billions of others living in connected lowland areas. Half of humanity depends on mountains for the provision of freshwater alone. Mountain ecosystems cool local temperatures, increase water retention, provide carbon storage, and reduce the risk of erosion and landslides. Mountain forests, wetlands and grasslands also host and support half the world's biodiversity hotspots. But the world's mountain ecosystems are under attack due to their particular sensitivity to the planetary crises of climate change, biodiversity loss, food insecurity, and pollution and waste. Evidence shows that mountain ecosystems are affected at a faster rate than many other terrestrial habitats.

This publication, jointly developed by the Mountain Partnership Secretariat at the Food and Agriculture Organization of the United Nations and the United Nations Environment Programme, analyses several mountain ecosystem restoration projects and recommends how the UN Decade's Ten Principles for Ecosystem Restoration can be applied to mountain ecosystems. Mountain restoration success stories from initiatives that have been selected or shortlisted as the UN Decade's World Restoration Flagships are also highlighted. As the theme of International Mountain Day 2023 is "Restoring Mountain Ecosystems", this publication provides an important contribution in addition to celebrating the Five Years of Action for the Development of Mountain Regions 2023–2027.

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